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the pole and adjust the clock-rates in order to ensure good following. For general work at varying declinations and hour-angles an elevation of about 60″ will probably be found best. For work in narrow zones, and near the meridian, other values of the elevation are found. Except near the equator the rotations of the field tend to counteract one another, and near the meridian the distortion is not very serious.

Astrographic chart plates, and plates intended for the parallax of clusters and nebulæ, fall into class B. For them it is a delicate matter to balance the respective merits or demerits of good following, absence of hand correction, rotation or distortion of the field. Near the equator and on the meridian it is best to adjust to the true pole, and sacrifice easy following to freedom from rotation, since distortion is fairly small. Far from the meridian distortion becomes so large that rotation is comparatively a minor ill. But here a small elevation of the pole has little effect on the following.

In high declinations the rotations compensate one another, and the distortions are small. It is here that the advantages of elevation of the pole are most fully realised, and there seems to be no reason why long exposure photographs should not be susceptible of very accurate measurement.

It is, however, useless to attempt to frame any general rules. Each case must be decided after a weighing of conflicting interests. But there seemed to be a want of numerical data on which to form a judgment. The tables contained in this paper were therefore calculated as a preliminary to the work which is to be shortly undertaken with the new photographic equatorial of the Cambridge Observatory; and they are now published in the hope that they may be found of more extended use.

Cambridge Observatory :
1898 *June* 4.

A Diagram showing the Conditions under which Observations for the Determination of Stellar Parallax are to be made. By Arthur R. Hinks, B.A.

(*Communicated by Sir R. S. Ball.*)

The diagram which is here described was constructed to facilitate the arrangement of the stellar parallax work to which the Director proposes to devote the new photographic equatorial of the Cambridge Observatory.

It shows for a star of any R.A. between the limits of declination 0° and +60°

a. The two days of the year on which the parallactic displacement of the star is a maximum.

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b. The mean time on those days at which it is most favourably situated for observation.

c. The hour-angle and zenith distance at which it is then to be observed.

The diagram thus serves as a guide in the choice of seasons for work on any star; and also as a guide to the order in which the photographs of all the stars in a night's working list should be taken, to avoid as far as possible large zenith distances.

I publish it now in the hope that the idea of such a diagram and the methods of its construction may be useful to others engaged in stellar parallax work.

The displacement of a star due to annual parallax is greatest at the two moments when the star is 90° from the Sun.

If then H and D are the hour-angle and declination of the Sun, h and δ the hour-angle and declination of a star, a condition for maximum parallactic displacement is

$$\text{Sin D} \sin \delta + \cos \text{D} \cos \delta \cos (\text{H} - h) = 0 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

I have assumed that it is possible to begin photographing when the Sun is 10° below the horizon. The corresponding hour-angle of the Sun, H, is given by the equation

$$\text{Cos } 100^\circ = \cos c \sin \text{D} + \sin c \cos \text{D} \cos \text{H} \quad . \quad . \quad . \quad . \quad (2)$$

where c is the colatitude of the observatory.

From equation (2) we find H the apparent time, and thence the mean time, at which it is possible to begin photographing on any day in the year. If in (1) we substitute this value of H and the corresponding value of D, we have a relation connecting the declinations and hour-angles at the time of beginning work of all the stars which are then at maximum parallactic displacement.

The construction of the diagram, therefore, proceeded as follows:—

The hour-angles H of the Sun when it reaches the zenith distance 100° were calculated from equation (2) for every fifteenth day of the year.

These values of H and the corresponding values of D were then substituted in equation (1), and the values of h obtained for every 10° of declination δ, from the equator to +60°. These values of h were plotted on millimetre paper, with dates as abscissæ and hour-angles as ordinates; and the curves drawn through the corresponding points of each set form the declination curves of the diagram.

Again, from the value of H we find the sidereal time at which the Sun reaches the zenith distance 100° on any day; and then we can lay down a series of points representing the hour-angles at this instant for stars of each hour of R.A. This was done for each fifteenth day; and the curves drawn through corresponding points of each series are the R.A. curves of the diagram.

Along the bottom were laid down for various dates the mean

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times corresponding to the calculated apparent times H at which the Sun reaches the zenith distance 100°.

In a precisely similar manner the curves were laid down which show the conditions under which the star is to be observed in the morning, when it is at the opposite apse of its parallactic ellipse.

Finally, at the right-hand side of the diagram, the curves were drawn which give for every 10° of declination the zenith distances corresponding to the hour-angles.

The use of the diagram is best illustrated by examples.

Suppose we require to observe for parallax a star in R.A. 10^h; Decl. +40°. The intersection of the corresponding curves gives May 7 as the date for the evening observation. The scale of mean times at the bottom shows that the Sun reaches the zenith distance 100° at about $8^h\ 45^m$ M.T. on that day. This is the time at which we can begin photographing. The scale of ordinates shows that the hour-angle of the star is then 29° W.; and the curves on the right give 23° as the corresponding zenith distance.

On the same evening we can see that stars whose positions are R.A. 9^h Decl. 0°, and R.A. 11^h Decl. +60° might be in the working list. At $8^h\ 45^m$ their respective zenith distances are 63° and 10°. We should therefore start at the earliest possible moment on the equatorial star. When that was done—in half an hour, say—we could get the star 40° N. at about 27° Z.D.; and after another half-hour the star 60° N. at 13° Z.D.

A simple inspection of the diagram gives then the conditions of hour-angle and zenith distance at the earliest times in the evening and the latest times in the morning at which the stars in the night's working list can be photographed. And in general these limiting times will be the best times for the work, since the zenith distances are then the smallest possible consistent with the conditions under which the work is to be done.

In some cases, however, the diagram shows that this is not true. For example, stars within 30° of the equator which are to be observed in the mornings in midwinter have passed the meridian when the Sun attains the zenith distance 100°; and it will be better to take them a little earlier, when they are on the meridian.

Granted fine weather, and the possibility of starting work very early in the evening and continuing it very late in the morning, it will be practicable, as the diagram shows, to avoid having to work at any hour-angle much exceeding three hours, except in the middle of summer, when the hour-angles for equatorial stars become almost prohibitively large. An extreme case is that of a star on the equator in R.A. 12^h, which in the case of the evening observation could not be photographed before it had reached the zenith distance 73°.

The diagram as published reproduces only too faithfully one or two irregularities, due to unskilful drawing of the original. All the declination curves should of course intersect in two

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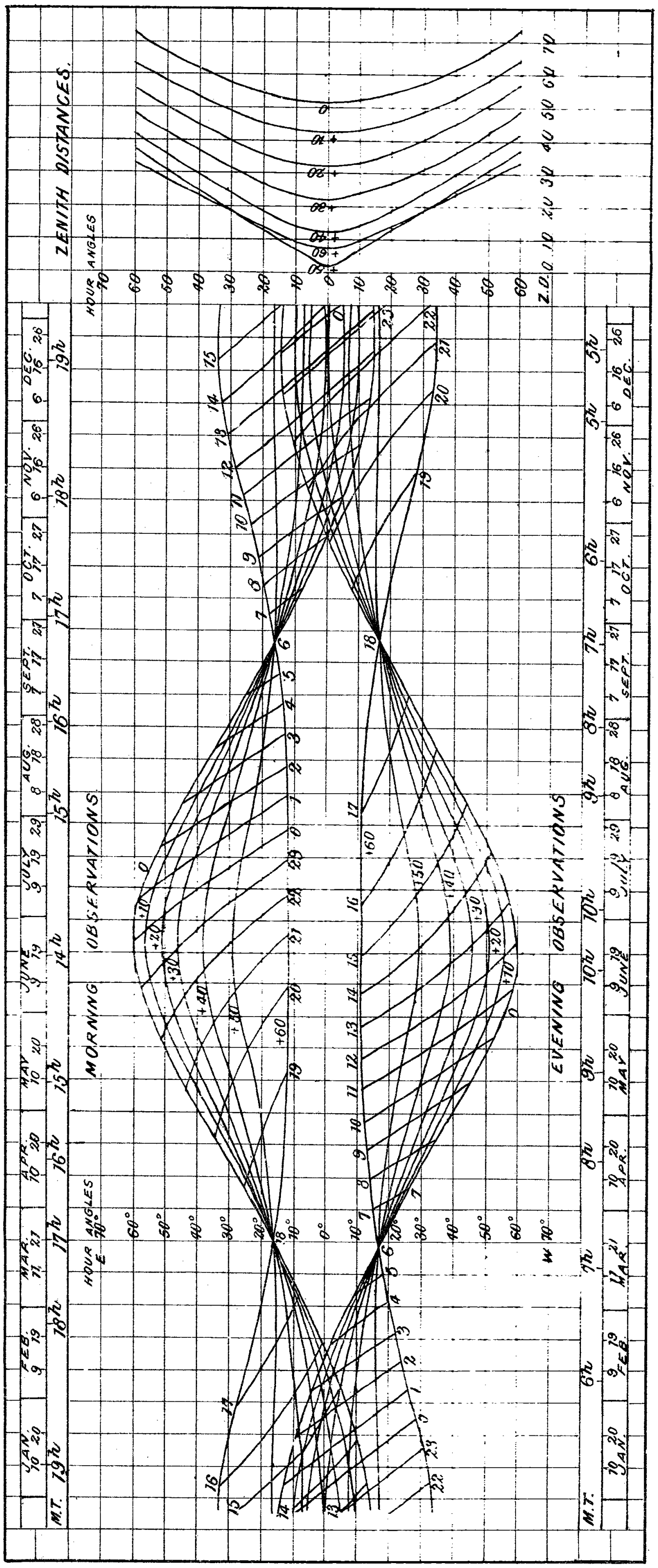
TIME CHART FOR PARALLAX OBSERVATIONS, CAMBRIDGE OBSERVATORY.



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points corresponding to the two equinoxes, which correspondence is in the drawing not quite exact. The accuracy of the drawing is, however, amply good enough for the purpose for which it was made.

Cambridge Observatory:
1898 *May* 28.

Revised Catalogue of the Stars of the IV. Type.
By the Rev. T. E. Espin, M.A.

The arrangement of the present catalogue is identical with that of the first catalogue of the Stars of the IV. Type, published in the *Monthly Notices*, vol. xlix. p. 364. The letter H has been used to signify the stars detected at the Harvard Observatory either visually, or by the photo-telescopes at Harvard and Arequipa. Professor Pickering has kindly sent me a complete list of these, containing some that have not hitherto been published. Also some notes on stars in the first catalogue, which, together with my own observations, have caused the removal of several stars from the list, and their being assigned to Type III. One star, No. 191, in the present catalogue, of which Professor Pickering writes, "Omit, not confirmed by the photographs," I have still ventured to retain, as although the star is not above 11·5 mag. I have no doubt as to the correctness of the earlier Harvard observations. I have observed it on several occasions, and although faint the type seemed certain. The stars in Column II. marked Es. and followed by a number, are stars not in the B.D. The other abbreviations in Column VI. are as follows: Se., Secchi; Du., Dunér; D'A., D'Arrest; P., Pechüle; V., Vogel.

The following is a general summary of the catalogue, the first column giving the limiting magnitude, the second the number of stars north of the equator, the third the number of stars south, and the last the totals, the variable stars being entered according to their maximum magnitude:—

Mag.	N.	S.	Total.
to 6·0	3	4	7
6·1 „ 7·0	12	11	23
7·1 „ 8·0	19	20	39
8·1 „ 9·0	51	25	76
Below 9·0	69	11	80
Mag. not given	1	11	12
Total	155	82	237

Excluding variables our knowledge of the number of stars of Type IV. is probably complete for the N. heavens as far as 8·9, and for the southern heavens as far as 8·5. The catalogue